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Evaluation of Commercial Pneumatic Bandage

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INTRODUCTION

A new commercial pneumatic bandage was received from the Academy of Health Sciences, Fort Sam Houston, TX, for test and evaluation as a wound control system. The product is advertised as being a fast and effective wound and trauma dressing that minimizes rescuer contact with blood, keeps the injured area warm, protects the wound from outside elements, and provides a comfortable air cushion during transport. An evaluation of the pressure characteristics of the device and related safety considerations was conducted. Comparisons between the device and more conventional elastic bandages were also made.

MATERIALS AND METHODS

Samples of the product, ComPresAid^R (R. Evans Corporation, Phoenix, AZ), were provided in three sizes (all 6" wide): small (15"), medium (21"), and large (33"). These sizes are designed to accomodate extremities spanning a wide range of shapes and dimensions. Included in each wound control package are one size of inflatable cuff, a pressure dressing (5" x 9" abdominal pad, or "Abd"), and a mouthpiece (Figure 1). In practice, the cuff is wrapped firmly around the dressing covering the injured site, and is fastened firmly in place with Velcro^R. The cuff is inflated by blowing into the attached mouth piece until "fit is snug and pressure is felt over the wound." A clasp is then snapped to contain air within the cuff. If the pressure is great

enough to cause loss of the previously palpated pulse, air must be released until the pulse returns.

The manufacturer was contacted regarding specific values of operating pressure to use, but no objective information could be obtained other than that the device could be safely pressurized to the point of Velcro^{R} separation. Therefore, plausible operating pressures were inferred from literature on similar products (air splints), which are recommended for control of hemorrhage in various trauma texts (Wiener and Barrett, 1986, Baxt, 1985, and Mattox et al., 1988). Guidelines for inflation pressure are not provided in these sources; however, manufacturers claim the splints can safely be inflated up to 40 mm Hg. Results from fracture immobilization studies conducted to determine what pressures produce tissue ischemia indicate that pressures of 15, 20 or 30 mm Hg may be more appropriate (Christensen et al., 1986, Sloan and Dove, 1984, and Yamaguchi and Yamaguchi, 1986). An orthopedic surgeon contacted regarding hemorrhage control suggested that 20 mm Hg would be appropriate for superficial and venous bleeding and that as much as 40-50 mm Hg may be needed for partial arterial tears (Sugarman, 1989).

Because of the ambiguity regarding proper operating pressure, performance tests on the product were conducted at the following values: 15, 20, 30 and 40 mm Hg. All three sizes of ComPresAid^{R} were studied, using a soft foam prosthetic forearm, and a standard aneroid manometer (calibrated with a mercury manometer). Surgical towels were wrapped around the arm to accomodate the two larger sized cuffs. The cuffs were inflated to the operating pressures under study for one hour--the maximum inflation time recommended in the product literature. Pressure was measured at 15 minute

intervals over the one hour time period, and the tests were replicated for each value of pressure and size of cuff. The pressure required to unfasten the Velcro^R for each size of cuff was measured, and the maximum cuff pressures that could be achieved from inflation by two different people were determined.

For comparison between the ComPresAid^R product and more conventional type bandages, a standard elastic bandage (National Stock Number 6510-00-103-9749), commonly referred to as an "Ace" bandage, was studied using the Abd supplied with ComPresAid^R as the wound covering. An Activated Charcoal Cloth Field Battle Dressing (Charcoal Cloth Limited, Berkshire, England) was also studied (Figure 2). The charcoal dressing is promoted as having all the advantages of an occlusive dressing with the additional advantage of bacterial control. The bandage is composed of a nonadherent wound contact layer; a charcoal layer for removal of bacteria, chemical warfare agent, and odor; an absorbent cotton layer for absorption of blood and exudate; an impermeable polyethylene layer for prevention of strike through; an outer cover for mechanical protection of the wound and camouflage of the dressing; and an integral length of elastic cohesive bandage for applying compression to and securing the dressing. The dressing is packed in a chemical proof pouch and supplied in two sizes: 10cm x 20cm and 20cm x 20cm. The smaller size was studied.

Pressure measurements using these bandages were made using a Cast Alert^R pressure transducer (Johnson & Johnson Orthopaedics, New Brunswick, NJ). The transducer was placed on a prosthetic arm, covered by the respective dressing, and calibrated using the ComPresAid^R cuff and aneroid manometer. Comparative tests were conducted by placing the Abd or charcoal dressing over the

transducer and securing it with the bandaging such that the same pressures studied for the ComPresAid^R evaluation were generated. As before, pressure measurements were taken at 15 minute intervals over a one hour period. Dimensions and weights of the various products were also determined.

RESULTS

The ComPresAid^R cuffs did not hold constant pressure over the one hour time period when inflated to any of the operating pressures studied (Table 1). Most of the pressure decay occurred during the first 15 minutes. The pressure versus time results for all three sizes of cuff were very similar, as were the values of maximum inflation pressure to separate the Velcro^R. The cuffs could be inflated to a maximum of roughly 80 mm Hg before unfastening. One person was able to inflate the small cuff to 80 mm Hg and the other could inflate it to 50 mm Hg. Pressures for the elastic and charcoal bandages remained essentially constant over the entire one hour period (Table 2). Dimensions and weights of the various products are shown in Table 3. The charcoal bandage is the most compact and lightweight, followed by the elastic bandage. The ComPresAid^R products are over 5 times as large and 1.5 to 3 times as heavy as the elastic bandages.

DISCUSSION

Use of the ComPresAid^R bandage could help control bleeding of extremity wounds, but not as well as could elastic bandages, based on the pressure data

taken. Pressures that would be considered unsafe for air splints/elastic bandages could be generated with the ComPresAid[R] product, at values comparable to those achieved by Sloan and Dove (1984) for air splints. Since there is no pressure gauge on the ComPresAid[R], users would have to rely on traditional subjective means of assessing pressure, which have been found to be unreliable in the use of air splints (Christensen et al., 1986). Even though there is substantial pressure decay when the ComPresAid[R] is inflated to higher pressures, defects in the equipment should not be relied upon for safety. Incorporation of a blow-off valve in the product might therefore be advisable.

Additional disadvantages of ComPresAid[R] as compared to elastic bandages include large size and weight, the requirement for 3 sizes of cuff to accomodate arms and legs, and the lack of capability to be used in unusually contoured areas, such as the shoulder. Although ComPresAid[R] is advertised as being rapid, no time savings in application is anticipated, due to the need to open 3 different packages before applying the Abd and inflating the cuff. Cost of the ComPresAid[R] system ($3.95) would be approximately 3 times greater than the cost of a standard elastic bandage. Cost data were unavailable for the charcoal bandage. No differences in hemorrhage control would be anticipated between the elastic and charcoal bandages.

CONCLUSIONS

The ComPresAid[R] device does not hold pressure as well as elastic bandages and has too many other disadvantages to be effective in the combat casualty care environment.

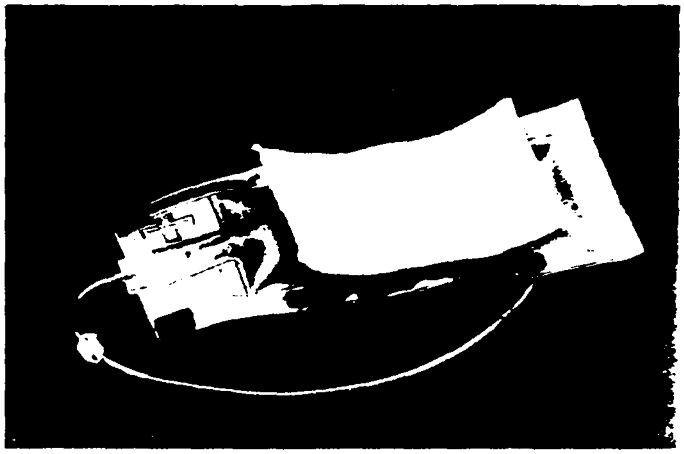

Figure 1. ComPresAid^{R} wound control system

Figure 2. Activated Charcoal Cloth Field Battle Dressing

Table 1. Pressure versus time for ComPresAid[R] wound control system inflated to 15, 20, 30 and 40 mm Hg (sizes S - small, M - medium, and L - large)

Elapsed Time (minutes)	Average Measured Pressure (mm Hg)											
	S	M	L	S	M	L	S	M	L	S	M	L
0	40	40	40	30	30	30	20	20	20	15	15	15
15	30	29	30	26	27	25	15	16	13	10	11	13
30	30	28	30	24	26	24	15	15	12	10	11	13
45	29	27	29	23	25	23	14	15	12	9	9	13
60	27	27	28	23	25	23	14	15	12	9	9	13

Table 2. Pressure versus time for Activated Charcoal Cloth Field Battle Dressing (CHAR) and Elastic bandage (ACE) applied at pressures of 15, 20, 30 and 40 mm Hg

Elapsed Time (minutes)	Average Measured Pressure (mm Hg)							
	CHAR	ACE	CHAR	ACE	CHAR	ACE	CHAR	ACE
0	40	40	30	30	21[a]	21[a]	15	15
15	40	40	30	30	21	21	15	15
30	39	40	30	30	21	21	15	15
45	39	40	30	30	20	21	15	15
60	39	40	30	30	20	21	15	15

[a]Pressure of exactly 20 mm Hg could not be achieved.

Table 3. Size and weight of ComPresAid^R, elastic bandage and Activated Charcoal Cloth Field Battle Dressing

Bandage	Packaged Volume (in^3)	Cuff/Tie Length (in)	Weight (grams)
Small ComPresAid^R	100	15	84
Medium ComPresAid^R	100	21	103
Large ComPresAid^R	100	33	143
Charcoal Bandage	18	68	54
Elastic + Abd	21	60	47

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